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PATENT APPLICATION

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IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Randy L. Hoffman et al.	Confirmation No.:	1458
Application No.:	10/799,961	Examiner:	KRAIG, William F.
Filing Date:	March 12, 2004	Group Art Unit:	2892

Title: Semiconductor Device with Multiple Component Oxide Channel

Mail Stop Appeal Brief - Patents
Commissioner For Patents
PO Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF REPLY BRIEF

Transmitted herewith is the Reply Brief with respect to the Examiner's Answer mailed on November 6, 2008 .

This Reply Brief is being filed pursuant to 37 CFR 1.193(b) within two months of the date of the Examiner's Answer.

(Note: Extensions of time are not allowed under 37 CFR 1.136(a))

(Note: Failure to file a Reply Brief will result in dismissal of the Appeal as to the claims made subject to an expressly stated new ground rejection.)

No fee is required for filing of this Reply Brief.

If any fees are required please charge Deposit Account 08-2025.

Respectfully submitted,
Randy L. Hoffman et al.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Patent Application of:

Randy L. Hoffman et al.

Application No.: 10/799,961

Filed: March 12, 2004

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REPLY BRIEF

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Alexandria, VA 22313-1450

Sir:

This is a Reply Brief under Rule 41.41 (37 C.F.R) in response to the Examiner's Answer of November 6, 2008 (the "Examiner's Answer" or the "Answer"). In Section 10, the Answer contains a response to some of the arguments made in Appellant's brief. Appellant now responds to the Examiner's Answer as follows.

Status of Claims

Claims 3-5, 19 and 57 were cancelled previously without prejudice or disclaimer.

Under the imposition of a previous Restriction Requirement, claims 21-36 and 45-47 were withdrawn from consideration and cancelled without prejudice or disclaimer.

Thus, claims 1, 2, 6-18, 20, 37-44 and 48-56 are currently pending in the application and stand finally rejected. Accordingly, Appellant appeals from the final rejection of claims 1, 2, 6-18, 20, 37-44 and 48-56.

Grounds of Rejection to be Reviewed on Appeal

The Answer maintains the following grounds of rejection.

(1) Claims 1, 2, 6-9, 18, 20, 37, 38 and 42-44 were rejected under 35 U.S.C. § 103(a) over the combined teachings of Hamada et al (JP Patent No. 405251705A) ("Hamada"), Phillips et al. ("Transparent Conducting Thin Films of $GaInO_3$," Appl. Phys. Let. Vol. 65 (1), July 1994) ("Phillips") and Narushima et al. ("Electronic structure and transport properties in the transparent amorphous oxide semiconductor 2 CdOGeO", Phys Rev. B 66, 035203-1, 7/16/2002) ("Narushima").

(2) Claims 10-13 and 39 were rejected as being unpatentable under 35 U.S.C. § 103(a) over the combined teachings of Hamada, Phillips, Narushima and Minami (of record).

(3) Claims 14-17 and 40-41 were rejected as being unpatentable under 35 U.S.C. § 103(a) over the combined teachings of Hamada, Phillips, Narushima, Minami (of record) and "D" ('Transparent Conducting PbO_2 films prepared by activated reactive evaporation," Phys. Rev. B 33, 2660-2664 (1986) ("D").

(4) Claims 48-52 were rejected as being unpatentable under 35 U.S.C. § 103(a) over the combined teachings of U.S. Patent No. 6,476,788 to Akimoto ("Akimoto"), Hamada, Phillips and Narushima.

(5) Claims 53 and 54 were rejected as being unpatentable under 35 U.S.C. § 103(a) over the combined teachings of Akimoto, Hamada, Phillips, Narushima and Minami (of record).

(6) Claims 55 and 56 were rejected as being unpatentable under 35 U.S.C. § 103(a) over the combined teachings of Akimoto, Hamada, Phillips, Narushima, Minami and D.

According, Appellant hereby requests review of each of these grounds of rejection in the present appeal.

Argument

(1) Claims 1, 2, 6-9, 18, 20, 37, 38 and 42-44:

Claim 1:

Claim 1 recites:

> A semiconductor device, comprising:
> a drain electrode;
> a source electrode;
> *a channel contacting the drain electrode and the source electrode, wherein the channel includes one or more compounds of the formula $A_xB_xO_x$, wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide, each O is atomic oxygen, where each x is a non-zero number, but the value of "x" for each constituent element may be different*, wherein the channel includes one of an amorphous form and a mixed-phase crystalline form; and
> a gate dielectric positioned between a gate electrode and the channel.

(Emphasis added).

In contrast, the Answer still concedes that "Hamada et al., however, fails to disclose that compounds include gallium-tin oxide or that the compounds forming the channel region include one of an amorphous form and a mixed-phase crystalline form or that each x in the formula $A_xB_xO_x$ is independently a non-zero number." (Answer, p. 5). Consequently, the Answer cites to Phillips as teaching "the use of $GaIn_{1-x}Sn_xO_3$ (wherein each x in the formula is independently a non-zero number) as a replacement for a layer of ITO." (Answer, p. 5) (citation omitted). The Answer also continues to rely on the teachings of Narusima for a showing that "it is desirable to use amorphous transparent oxide as a semiconductor material." (Answer, p. 5).

As Appellant has previously pointed out, the Answer has substantially misapprehended the Phillips reference. In pertinent part, Phillips teaches "$GaIn_{1-x}Sn_xO_3$, for $0 \leq x \leq 0.20$." (Phillips p. 115). Thus, Phillips is teaching a material which includes both

$GaInSnO_3$ molecules and $GaInO_3$ molecules, the average over the entire material being represented by $GaIn_{1-x}Sn_xO_3$, where $0 \leq x \leq 0.20$. Indium is a constituent of each molecule. Consequently, Phillips does not teach or suggest gallium-tin oxide as recited in claim 1. Rather, Phillips only teaches gallium-indium-tin oxide or gallium-indium oxide. Therefore, the combination of Hamada and Phillips fails to teach or suggest the claimed channel "wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide."

In response to these points, the final Office Action argued that "the limitations of claim 1 are open-ended, and the compounds ($A_xB_xO_x$) referred to therein can contain other elements (i.e, the gallium-tin oxide referred to in claim 1 can, within the scope of the claim, contain indium). It has been held that the use of the term 'comprising' leaves a claim open for inclusion of material or steps other than recited in the claims." (final Office Action, p. 23). The Answer extends this argument to hold that, not only is the claim open-ended, but also, "the limitation in question is open-ended" such that the otherwise clear and plain recitation is construed as reading on any chemical compound the contains the listed and additional constituents. (Answer, p. 24). This is utterly unreasonable.

Appellant agrees that the term "comprising" leaves a claim open for the inclusion of other elements not recited. However, the use of the term "comprising" certainly does not mean that each element of a claim is also open-ended such that a recited chemical compound can be disregarded or can read on any chemical compound that contains the same and additional constituents. There is absolutely no authority for such an interpretation of the applicable law and rules of practice.

In this regard, the Answer cites to *Ex parte Davis*, 80 USPQ 448 (1948). According to the Answer, *Davis* holds that "the term 'comprising' leaves a claim open for inclusion of unspecified ingredients other than recited in the claims, *even in major amounts.*" (Answer, p. 25) (emphasis in original). As above, *Davis* does hold that a the term "comprising" leaves a *claim* open for the inclusion of additional recited elements. It is, however, a complete mischaracterization of *Davis* to argue that *Davis* holds that each limitation is individually open-ended, such that the recitation of a particular chemical compound can be essentially ignored and transfigured into a recitation of any compound comprising the recited and additional constituents. Such an unreasonable interpretation would make it unreasonably difficult for an applicant to specify precisely the desired chemical compounds to be recited in a claim. The Examiner's interpretation of *Davis* is unreasonable, unworkable and utterly without supporting authority!

Claim 1 expressly recites "wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide." Anyone of any skill in the art will appreciate that the gallium-tin oxide recited in claim 1 is different from the gallium-indium-tin oxide taught by the cited prior art. Claim 1 does not recite gallium-indium-tin oxide, and the Examiner's attempt to read this subject matter into claim 1 so that the prior art can apply is entirely and obviously inappropriate. Again, the use of the term "comprising" does not license the Examiner to change or add to the chemical compounds specifically and expressly recited.

In support of the position that all claim limitations are open-ended, the Answer also points to the instant claims 6 and 51 (*which both state "wherein the one or more compounds of the formula $A_xB_xO_x$ includes C_x, to form a compound of the formula $A_xB_xC_xO_x$).* It is clear from these claims, which depend from, and refer back to claims

> 1 and 48, that the limitation "one or more compounds of the formula $A_xB_xO_x$ " is intended to be open-ended and can therefore be reasonably interpreted to include compounds of the formulae $A_xB_xC_xO_x$ such as gallium-indium-tin oxide. The Examiner further notes that instant claims 10 and 53 (*which both state "wherein the one or more compounds of formula $A_xB_xC_xO_x$ includes O_x, to form a compound of the formula $A_xB_xC_xD_xO_x$*) and the instant claims 14 and 55 (*which both state "wherein the one or more compounds of formula $A_xB_xC_xD_xO_x$ includes Ex, to form a compound of the formula $A_xB_xC_xD_xE_xO_x$*) contain similar limitations.

(Answer, p. 25) (emphasis in original).

Appellant appreciates the point that the Answer is here making. However, claim 1 expressly recites "wherein the one or more compounds of the formula AxBxOx includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide." Consequently, claims 6, 51, 10, 53, 14 and 55, as cited by the Answer, must be construed as including "one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide" *in addition to* a compound that adds one or more additional constituents.

It is still fundamentally beyond question that gallium-tin oxide as recited in claim 1, for example, is not the same thing as gallium-indium-tin oxide or gallium-indium oxide as taught by Phillips. Since claim 1 recites a compound that includes "one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide," one of those compounds must be present. As demonstrated above, the prior art does not teach or suggest any of these recited compounds in the channel of a semiconductor device as recited in claim 1. For at least these reasons, the rejection of Appellant's claims should not be sustained.

Additionally, Phillips does not, as alleged by the Office Action, teach or suggest "where each x is a non-zero number, but the value of "x" for each constituent element may be different," as recited in claim 1. According to the Answer, "Appellant further argues that 'the

x given in the formula $Ga_1n_{1-x}Sn_x0_3$ (of Phillips et al.) be the same for both instances of 'x'". (Answer, p. 25). This was not, however, a mere argument on the part of Appellant, rather it is a quote Appellant took directly from Phillips. Phillips expressly states that, "[w]hile x may vary depending on the relative concentration of $GaInSnO_3$ molecules and $GaInO_3$ molecules in a sample of material, *the x given in the formula* $GaIn_{1-x}Sn_xO_3$ *be the same for both instances of "x."* (Phillips, p. 115) (emphasis added).

Consequently, the arguments in the Answer that Phillips could be construed as allowing "x" to be a different number if different instances (Answer, p. 25) are simply contrary to the express teachings of Phillips quoted by the Appellant and have no merit whatsoever.

Finally, Phillips does not reasonably teach or suggest replacing the ITO layer of Hamada as suggested by the Office Action. (Action, p. 4). Appellant notes that the ITO channel taught by Hamada is, and must be, a *semi conducting* material or the transistor is non-functional. In contrast, the Phillips reference relates to "transparent *conducting* thin films." (Phillips, title). As noted in the first paragraph of Phillips, "Indium tin oxide (ITO) has become the [transparent ***conducting*** oxide] TCO of choice for a wide variety of applications." (Phillips, p. 115).

Consequently, Phillips may be viewed as suggesting the replacement of an ITO layer with GIO, GGIO, or GITO, *within the context of using such layers as highly-conductive "transparent conducting" materials*. Nowhere, however, does Phillips suggest using GIO, GGIO, or GITO layers in applications where a high-resistance semi conductive material is desired, such as, for example, in the thin-film transistor channel layer described by Hamada.

Thus, it is unreasonable to suggest that one of skill in the art would consider Phillips, which references ITO as a transparent *conducting* material, as suggesting to one of skill in the art that a *semi conducting* ITO layer should be replaced with some other transparent *conducting* material that is equivalent to ITO in an entirely separate use and context.

In this regard, the Answer again argues that one of skill in the art would have disregarded these express teachings from the cited prior art to make the proposed combination. (Answer, p. 26). According to the Answer, "[t]he Examiner argues that one of ordinary skill in the art, combining Harada et al. and Phillips et al. would have known that transparent conducting oxides (including GainSnO (GITO) and ITO) exhibit semiconductive properties, and thus would not have been deterred from making the combination. Forrest et al. (U.S. Patent # 6198091) provides evidence that GITO and ITO are known in the art to be transparent conducting oxides exhibiting semiconductive properties (Forrest et al., Col. 5, lines 25-40)." (Answer, p. 26).

Appellant respectfully submits that the Answer has seriously misread the teachings of the newly-cited Forrest reference. At the portion cited, Forrest describes GITO and ITO as conductive "metal substitutes."

> Commonly used ***metal substitutes*** for electrodes and charge transfer layers would include wide bandgap semiconductors, for example, transparent ***conducting*** oxides such as indium tin oxide (ITO), tin oxide (TO), gallium indium tin oxide (GITO), zinc oxide (ZO) and zinc indium tin oxide (ZITO). In particular, ITO is a highly doped degenerate n+ semiconductor with an optical bandgap of approximately 3.2 eV rendering it transparent to wavelengths greater than approximately 3900 .ANG..

(Forrest et al., Col. 5, lines 25-40).

Thus, Forrest teaches that ITO is semiconductor that has been "highly doped" to become a "conducting" "metal substitute."

Consequently, there is nothing in Forrest that would contradict the clear teachings of Phillips that indicated materials are conductive and, therefore, not suitable in place of the

semi-conducting material needed by Hamada. Clearly, the proposed combination of the teachings of Phillips and Hamada in the Answer is illogical and would clearly not have been made by one of ordinary skill in the art.

The Supreme Court recently addressed the issue of obviousness in *KSR Int'l Co. v. Teleflex Inc.*, 127 S.Ct. 1727 (2007). The Court stated that the *Graham v. John Deere Co. of Kansas City*, 383, U.S. 1 (1966), factors still control an obviousness inquiry. Under the analysis required by *Graham v. John Deere*, 383 U.S. 1 (1966) to support a rejection under § 103, the scope and content of the prior art must first be determined, followed by an assessment of the differences between the prior art and the claim at issue in view of the ordinary skill in the art. In the present case, the scope and content of the prior art, as evidenced by Hamada, Phillips and Narushima (with evidence from newly-cited Forrest), did not include much of the claimed subject matter.

Specifically, the claimed channel that "includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide" appears to be outside the scope and content of the prior art. The claimed channel with a material defined by the formula $A_xB_xO_x$, "where each x is a non-zero number, but the value of "x" for each constituent element may be different," is also outside the scope and content of the cited prior art. Moreover, the combination of Hamada and Phillips, as proposed in the Office Action, would not have been reasonable to one of ordinary skill in the art.

Clearly, the Answer has failed to accurate determine the scope and content of the prior art or the differences between the claimed subject matter and cited prior art as required by *KSR* and *Graham*. Consequently, the cited prior art will not support a rejection of claim 1 under 35 U.S.C. § 103 and *Graham*.

Claim 18:

Claim 18 similarly recites:

> A semiconductor device, comprising:
> a drain electrode;
> a source electrode;
> *means for controlling current flow electrically coupled to the drain electrode and the source electrode, wherein the means for controlling current flow includes one or more compounds of the formula $A_xB_xO_x$, wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide, where each x is a non-zero number, but the value of "x" for each constituent element may be different*, wherein the channel includes one of an amorphous form and a mixed-phase crystalline form; and
> a gate electrode separated from a channel by a gate dielectric.

(Emphasis added).

For the same reasons given above, the combination of Hamada, Phillips and Narushima fails to reasonably teach or suggest the claimed device with "means for controlling current flow electrically coupled to the drain electrode and the source electrode, wherein the means for controlling current flow includes one or more compounds of the formula $A_xB_xO_x$, wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide, where each x is a non-zero number, but the value of "x" for each constituent element may be different." This subject matter has been shown to lie outside the scope and content of the cited prior art for the reasons given above. Therefore, the cited prior art will not support a rejection of claim 18 under 35 U.S.C. § 103 and *Graham*.

Claim 37:

Claim 37 recites:

> A semiconductor device formed by the steps, comprising:
> providing a drain electrode;
> providing a source electrode;

providing a precursor composition including one or more precursor compounds that include A_x and one or more compounds that include B_x, wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide, where each x is a non-zero number, but the value of "x" for each constituent element may be different, wherein the channel includes one of an amorphous form and a mixed-phase crystalline form;

depositing a channel including the precursor composition to form a multicomponent oxide from the precursor composition to electrically couple the drain electrode and the source electrode;

providing a gate electrode; and

providing a gate dielectric positioned between the gate electrode and the channel.

For the same reasons given above, the combination of Hamada, Phillips and Narushima fails to reasonably teach or suggest the claimed device "wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide, where each x is a non-zero number, but the value of "x" for each constituent element may be different." This subject matter has been shown to lie outside the scope and content of the cited prior art for the reasons given above. Therefore, the cited prior art will not support a rejection of claim 37 under 35 U.S.C. § 103 and *Graham*.

(2) Claims 10-13 and 39:

This rejection should not be sustained for at least the same reasons given above in favor of the patentability of claims 1 and 37.

(3) Claims 14-17 and 40-41:

This rejection should not be sustained for at least the same reasons given above in favor of the patentability of claims 1 and 37.

(4) Claims 48-52:

Independent claim 48 recites:

> A display device, comprising:
> a plurality of pixel devices configured to operate collectively to display images, where each of the pixel devices includes a semiconductor device configured to control light emitted by the pixel device, the semiconductor device including:
> a drain electrode;
> a source electrode;
> a channel contacting the drain electrode and the source electrode, *wherein the channel includes one or more compounds of the formula $A_xB_xO_x$, wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide, each O is atomic oxygen, where each x is a non-zero number, but the value of "x" for each constituent element may be different,* wherein the channel includes one of an amorphous form and a mixed-phase crystalline form;
> a gate electrode; and
> a gate dielectric positioned between the gate electrode and the channel and configured to permit application of an electric field to the channel.

(Emphasis added).

For the same reasons given above, the combination of Hamada, Phillips and Narushima fails to reasonably teach or suggest the claimed device including a transistor channel "wherein the one or more compounds of the formula $A_xB_xO_x$ includes one or more of gallium-germanium oxide, gallium-tin oxide, gallium-lead oxide, indium-germanium oxide, indium-lead oxide, each O is atomic oxygen, where each x is a non-zero number, but the value of "x" for each constituent element may be different." This subject matter has been shown to lie outside the scope and content of the cited prior art for the reasons given above.

Akimoto does not remedy the deficiencies of Hamada and Phillips explored above. Rather, Akimoto is merely cited for the context of transistors used in a display device with a plurality of pixel devices. Therefore, the cited prior art will not support a rejection of claim 48 under 35 U.S.C. § 103 and *Graham*.

(5) Claims 53 and 54:

This rejection should not be sustained for at least the same reasons given above in favor of the patentability of claim 48.

(6) Claims 55 and 56:

This rejection should not be sustained for at least the same reasons given above in favor of the patentability of claim 48.

In view of the foregoing, it is submitted that the final rejection of the pending claims is improper and should not be sustained. Therefore, a reversal of the Rejection of 11 April 2008 is respectfully requested.

Respectfully submitted,

DATE: January 6, 2009

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